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09/975,257	10/12/2001	Sundar Narayanan	8229-013-27	8852

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EXAMINER	
HOGANS, DAVID L	
ART UNIT	**PAPER NUMBER**
2813	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/975,257	Applicant(s) NARAYANAN ET AL.	
	Examiner David L. Hogans	Art Unit 2813	

-- The MAILING DATE of this communication appears on th cover sheet with the correspond nc address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _12 April 2004_.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1-3 and 5-22_ is/are pending in the application.

4a) Of the above claim(s) _20-22_ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _1-3 and 5-19_ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on _12 October 2001_ is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

This Office Action is in response to the Amendment filed on April 12, 2004.

Status of Claims

Claims 1-3 and 5-19 are pending. Claims 20-22 are withdrawn. Claim 4 has been cancelled. Claim 10 was submitted as "Previously Presented" in the April 12, 2004, amendment. The Examiner notes there were several changes to Claim 10 in the April 12, 2004, amendment. As such, it should have been labeled "Currently Amended".

Claim Objections

1. Claims 17 and 18 are objected to because of the following informalities: Claims 17 and 18 depend from Claim 4, which is a cancelled claim. The Examiner will construe Claims 17 and 18 as depending from Claim 1. Appropriate correction is required.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1, 3, 5-7, 9-10 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP2000-311928 to Yasushi in view of 6,721,046 to Halliyal et al.

Claim 1

Yasushi teaches oxidizing the nitrided gate oxide layer (3) on the substrate (1); measuring the thickness (L2) of the oxidized nitrided gate oxide layer (4); optionally calculating the change in thickness of the oxidized nitrided gate oxide layer; and determining if the measured thickness or calculated change in thickness of the oxidized nitrided gate oxide layer exceeds a predetermined value (i.e. - a 40 angstrom target thickness) (See Figures 1 and 2 and translation pages 1-2)

Yasushi fails to explicitly teach nitriding a gate oxide layer on a semiconductor substrate using nitric oxide gas to form the nitrided gate oxide layer on the substrate.

However, Halliyal et al., in column 7 lines 20-36, teaches nitriding a gate oxide layer on a semiconductor substrate using nitric oxide gas to form the nitrided gate oxide layer on the substrate.

It would have been obvious to one of ordinary skill in the art to modify Yasushi by incorporating nitriding a gate oxide layer on a semiconductor substrate using nitric oxide gas to form the nitrided gate oxide layer on the substrate, as taught by Halliyal et al., because NO oxidation produces a higher amount of nitrogen incorporation at the Si/SiO2 interface than does N2O oxidation (i.e. - a higher amount of nitrogen incorporation at the Si/SiO2 interface reduces dopant migration).

Claim 3

Incorporating all arguments of Claim 1 and noting that Yasushi teaches correlating the measured thickness or change in thickness of the oxidized nitrided gate oxide layer with the nitrogen content of the gate oxide layer. (See Figures 1 and 2 and translation pages 1-2)

Claim 5

Incorporating all arguments of Claim 1 and noting that Yasushi teaches forming an initial oxide layer (2) on the substrate (1) prior to the nitriding step. (See Figures 1 and 2 and translation pages 1-2)

Claim 6

Incorporating all arguments of Claims 1 and 3 and noting that Yasushi teaches measuring the oxidized nitrided gate oxide thickness (L2) for a plurality of samples each having a known nitrogen content; optionally calculating the change in thickness after oxidizing the nitrided gate oxide layer for each sample; and performing a least squares regression analysis to generate a calibration curve for nitrogen content of the nitrided gate oxide as a function of oxidized nitrided gate oxide thickness or change in oxidized nitrided gate oxide thickness. (See Figures 1 and 2 and translation pages 1-2)

Claim 7

Incorporating all arguments of Claim 1 and noting that Yasushi teaches wherein the step of determining the change in thickness of the oxidized nitrided gate oxide layer

(L2) comprises determining the initial gate oxide thickness by measuring the thickness of the gate oxide layer prior to the oxidation step (L1) and calculating the difference between the measured oxidized nitrided gate oxide layer thickness and the initial gate oxide thickness (i.e. – [[L2-L1]/T]). (See Figures 1 and 2 and translation pages 1-2)

Claim 9

Incorporating all arguments of Claims 1 and 7 and noting that Yasushi teaches wherein the initial gate oxide thickness is measured after the nitridation step (L1). (See Figures 1 and 2 and translation pages 1-2)

Claim 10

Incorporating all arguments of Claim 1 and noting that Yasushi teaches wherein calculating the change in thickness of the oxidized nitrided gate oxide layer (L2) comprises determining an initial gate oxide thickness by estimating the thickness of the gate oxide layer (L1) prior to the oxidation step and calculating the difference between the measured oxidized nitrided gate oxide layer thickness and the initial gate oxide thickness (i.e. – [[L2-L1]/T]). (See Figures 1 and 2 and translation pages 1-2)

The Examiner notes that an initial gate oxide thickness can be estimated by taking a measurement.

Claim 12

Incorporating all arguments of Claim 1 and noting that Yasushi teaches measuring the concentration of nitrogen in a gate oxide layer. (See Figures 1 and 2 and translation pages 1-2)

Although Yasushi fails to explicitly teach the formation of a gate electrode layer, the Examiner deems the formation of a gate electrode layer as inherent to the disclosure of Yasushi because the scope of Yasushi entails a judgment method for nitrogen concentration in a gate oxide film. See MPEP § 2112

3. Claims 8 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP2000-311928 to Yasushi in view of 6,721,046 to Halliyal et al.

Claim 8

Incorporating all arguments of Claims 1 and 7 and noting that Yasushi and Halliyal et al. fail to explicitly teach wherein the initial gate oxide thickness is measured before the nitridation step. Noting that Yasushi and Halliyal et al. do teach measuring the gate oxide thickness after the nitridation step.

However, the specification contains no disclosure of either the critical nature of the claimed process (i.e. - measuring the gate oxide thickness before the nitridation step) or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen limitations or upon another variable recited in a claim, the

Applicant must show that the chosen limitations are critical. *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990)

In light of Applicant's failure to establish criticality, the limitation of measuring the gate oxide thickness before the nitridation step is deemed equivalent to the limitation of measuring the gate oxide thickness after the nitridation step.

Claim 11

Incorporating all arguments of Claims 1 and 10 and noting that Yasushi and Halliyal et al. fail to explicitly teach wherein the initial gate oxide thickness is estimated from previously collected gate oxide thickness data.

However, the specification contains no disclosure of either the critical nature of the claimed process (i.e. - estimating the gate oxide thickness from previously collected gate oxide thickness data) or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen limitations or upon another variable recited in a claim, the Applicant must show that the chosen limitations are critical. *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990)

In light of Applicant's failure to establish criticality, the limitation of estimating the gate oxide thickness from previously collected gate oxide thickness data is deemed equivalent to estimating the gate oxide thickness via measurement.

4. Claims 2 and 14-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP2000-311928 to Yasushi in view of 6,721,046 to Halliyal et al. further in view of Silicon Processing for the VLSI Era (Volumes 1-3) to Wolf et al.

Claim 2

Incorporating all arguments of Claim 1 and noting that Yasushi and Halliyal et al. fail to explicitly teach thermal oxidation of the nitrided gate oxide layer by rapid thermal processing.

However, Wolf et al., on page 310 (vol. 1), teaches that RTP is emerging as the tool of choice for growth of ultra thin gate oxides and oxynitrides. Furthermore, Wolf et al. teaches that RTP allows for reduced thermal budget and a higher processing temperature.

It would have been obvious to one of ordinary skill in the art to modify Yasushi and Halliyal et al. by incorporating growth of oxides and oxynitrides via RTP, as taught by Wolf et al., to reduce thermal budgets and to operate at higher temperatures, thereby reducing transient enhanced diffusion effects and improving oxide quality.

Claim 14

Incorporating all arguments of Claims 1 and 12 and noting that Yasushi and Halliyal et al. fail to explicitly teach equating the predetermined value to a sufficient nitrogen content to prevent boron atoms from diffusing.

However, Wolf et al., on pages 313 and 649 (vol. 3), teaches that a gate oxide subjected to nitridation will provide a barrier to boron migration.

It would have been obvious to one of ordinary skill in the art to modify Yasushi and Halliyal et al. by incorporating a gate oxide subjected to nitridation that will provide a barrier to boron migration, as taught by Wolf et al., because it is well known within the art to selectively dope an oxide layer with a specified nitrogen concentration to prevent boron diffusion.

Claims 15 and 16

Incorporating all arguments of Claim 1 and noting that Yasushi and Halliyal et al. fail to explicitly teach wherein the oxidation step is conducted at a temperature of 900 to 1025 °C and for 10 minutes or less.

However, Wolf et al., on page 653 (vol. 3), teaches reoxidation of a nitrided gate oxide layer at a temperature of 950 to 1150 °C for about 60 seconds. Furthermore, Wolf et al. teaches that these are common process conditions for the reoxidation of a nitrided oxide layer.

It would have been obvious to one of ordinary skill in the art to modify Yasushi and Halliyal et al. by incorporating the reoxidation of a nitrided gate oxide layer at a temperature of 950 to 1150 °C for about 60 seconds, as taught by Wolf et al., because these are the process conditions commonly employed to create such a layer.

Claims 17 and 18

Incorporating all arguments of Claim 1 and noting that Yasushi, in pages 1-2 of the translation, teaches performing the oxidation and nitridation steps in the same chamber but fails to explicitly teach wherein the oxidation step and nitridation step are performed in different tools.

However, the Examiner deems performing the oxidation and nitridation steps in the same chamber as equivalent to performing oxidation and nitridation in different tools because the end results are the same.

Finally, the specification contains no disclosure of either the critical nature of the claimed process or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen limitations or upon another variable recited in a claim, the Applicant must show that the chosen limitations are critical. *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990)

5. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over JP2000-311928 to Yasushi in view of 6,721,046 to Halliyal et al. further in view of Semiconductor Manufacturing Technology to Quirk et al.

Incorporating all arguments of Claims 1 and 12 and noting that Yasushi and Halliyal et al. fail to explicitly teach implanting boron atoms into a gate electrode.

However, Quirk et al., on page 477, teaches a polysilicon electrode doped with boron.

It would have been obvious to one of ordinary skill in the art to modify Yasushi and Halliyal et al. by incorporating a polysilicon electrode doped with boron, as taught by Quirk et al., to enhance the electrical conductivity of the electrode.

6. Claim 19 rejected under 35 U.S.C. 103(a) as being unpatentable over 5,862,054 to Li in view of JP2000-311928 to Yasushi further in view of 6,721,046 to Halliyal et al.

Li teaches: collecting process parameter data for each batch (30); storing parameter data in a data base (32); computing an average value for each stored parameter (32); storing the average values in a historical data file on a computer (33); determining process control limits from the stored historical data file (34); and monitoring the process parameters and comparing these values to control limits. (See

Figure 3 and column 4 lines 1-20) Li also inherently teaches that any of the above steps can be repeated to obtain necessary data for statistical process control.

Li fails to explicitly teach for each substrate in a batch of semiconductor substrates, nitriding a gate oxide layer on the semiconductor substrate using nitric oxide gas to form the nitrided gate oxide layer on the substrate, oxidizing the nitrided gate oxide layer on the substrate to form an oxidized nitrided gate oxide layer.

However, Yasushi, in Figures 1 and 2 and pages 1-2 of the translation, and Halliyal et al., in columns 6-14 lines 45-20, teaches for each substrate in a batch of semiconductor substrates, nitriding a gate oxide layer on the semiconductor substrate using nitric oxide gas to form the nitrided gate oxide layer on the substrate, oxidizing the nitrided gate oxide layer on the substrate to form an oxidized nitrided gate oxide layer. Yasushi and Halliyal et al. teach that one would correlate these two parameters to determine the nitrogen concentration.

It would have been obvious to one of ordinary skill in the art to modify Li by incorporating for each substrate in a batch of semiconductor substrates, nitriding a gate oxide layer on the semiconductor substrate using nitric oxide gas to form the nitrided gate oxide layer on the substrate, oxidizing the nitrided gate oxide layer on the substrate to form an oxidized nitrided gate oxide layer, as taught by Yasushi and Halliyal et al., to determine the nitrogen concentration in a gate oxide layer.

Response to Arguments

7. Applicant's arguments with respect to claims 1-3 and 5-19 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

8. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to David L. Hogans whose telephone number is (571) 272-1691. The examiner can normally be reached on M-F (7:30-4:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr. can be reached on (571) 272-1702. The fax phone

number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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